THE RELATIONSHIP OF CONDITION SCORE AND SOW WEIGHT WITH PREWEANING TRAITS IN SWINE

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CHAPTER I

INTRODUCTION

The recommended feeding levels for sows vary according to their stage of production. Research with gilts has shown that increased feeding levels just prior to breeding usually increases ovulation rates; however, gilts maintained on high levels of intake after breeding have increased embryonic mortality. It is apparent that overfeeding may result not only in feed wastage, but also in reduction in productivity.

In recent years, widespread use of feeding stalls has enabled swine producers to feed sows individually. Starting in 1965, each sow in the swine breeding herd was given a condition score and in 1966 individual sow feeding stalls were made available in an effort to feed each sow according to her condition.

This study was initiated: (1) to determine the relationship between sow condition score and productivity when sows were limited fed in groups; (2) to appraise the effectiveness of individual feeding sows during gestation to obtain the desired condition at farrowing.

CHAPTER II

LITERATURE REVIEW

This literature review deals with the influence of sow weight and condition at breeding, farrowing and weaning on reproductive performance.

Sow Weight and Condition at Breeding

In a study of litter records in the Oklahoma swine breeding herd, Omtvedt, Stanislaw and Whatley (1965) found that breeding weight was significantly correlated to litter size (0.19), litter birth weight (0.24) and average pig birth weight (0.16). Steward (1944) found that litter size tended to increase with weight of the gilt at breeding, but it accounted for only three percent of the variance in litter size. Self, Grummer and Casida (1955) found no significant correlation between gilt weight at second estrus and ovulation rate. However, rate of gain from the first estrus to the second was positively associated (0.24) with ovulation rate at second estrus. Robertson et al. (1951a) obtained a nonsignificant correlation of 0.30 between second estrus ovulation rate and weight of the animal at that estrus using Chester Whites; but among the Poland gilts they obtained a significant correlation of -.52 between the two variables. They concluded that this response was unimportant since it was inconsistent with any of the other group correlations.

An increased feed intake just prior to breeding, has been shown to increase ovulation rates. Christian and Nofziger (1952) reported that full-fed gilts had an average ovulation rate of 15.1; whereas, limited-fed gilts (70 percent of full-fed) ovulated an average rate of 13.4. Haines, Warnick and Wallace (1955) divided 46 gilts into full-fed and limited-fed (50 percent of the energy of full-fed) groups and found that the full-fed gilts ovulated 3.5 more ova at first estrus and 3.9 more the second estrus than did limited-fed. Similar results were reported by Haines, Warnick and Wallace (1959) when their first experiment was enlarged by adding 56 gilts for the second year. Self _et al._ (1955) reported that full feeding was only necessary for a short period of time to increase ovulations. The number of ova recovered at the second estrus from gilts that had been full-fed from the time they were 70 days old (13.6) was significantly different from the number recovered from limited-fed gilts (11.1) over the same period. However, gilts that were limited-fed to first estrus and then full-fed through second estrus produced 13.5 ova. Robertson _et al._ (1951a) found that full-fed gilts ovulated 1.1 more ova at the second estrus than did limited-fed. In contrast to these reports, Gossett and Sorenson (1956, 1959) reported nonsignificant differences in ovulation rates between two levels of energy. They had a high level of 93 therms of energy per hundred pounds of feed and a low level of 55 therms. They concluded that the lower ovulation rates other workers had found were caused by factors other than energy in the feed. However, a difference of 1.1 ova was detected between their high and low energy levels. Zimmerman, Self and Casida (1957) also reported that flushing increased ovulation rates. Gilts which were flushed beginning on the eighth, twelfth, or sixteenth day of the estrus cycle ovulated more ova than the nonflushed controls. The two shorter periods of flushing (twelfth and sixteenth days) both showed the larger increase in ovulation from the first to the second estrus. The increases in ovulation rates range from 1.1 to 2.2 in the Chester White X Poland China crossbred gilts and 1.7 to 3.0 in the Chester Whites.

Condition at breeding has also been shown to influence reproductive performance. Self et al. (1955) suggested that the fatness of the young animal may affect age at puberty since the full-fed gilts were older at puberty. Gossett and Sorenson (1959) obtained a correlation of 0.45 between age and weight at puberty. Robertson et al. (1951b) also reported full-fed gilts were heavier at puberty, but differences in age at puberty were not significant.

Hafez (1959) found a positive relationship between backfat thickness and the number of services per conception. Fifteen percent of the gilts in the experiment required 2-3 services per conception, and these were the ones that were fatter.

Pike and Boaz (1966) found that fetal weight was influenced more by condition of the sow at the time of service than by level of feed during pregnancy. They noted that thinner sows at time of breeding had lower average total fetal weights than those in a fatter condition regardless of their feed level during pregnancy. The sows were subjected to either a high or low plane of nutrition during the latter five weeks of lactation to produce either the fat or thin condition at breeding. After breeding, the sows were either placed on a high level (8 lbs. per day) or a low level of one half of the high level. Their results are summarized in Table I.

TABLE I

MEAN FETAL WEIGHT OF SOWS SLAUGHTERED 70 DAYS POST-BREEDING (PIKE AND BOAZ, 1966)

Breeding Condition	Feeding Level During Gestation	
	High	Low
Fat	3675 g.	3447 g.
Thin	3227 g.	2675 g.

Based on the data available in the literature, it appears that condition of the sow may affect age at puberty, number of services per conception, and fetal weight.

Gestation Weight and Condition Changes

It is particularly important during gestation to control sow weight and condition. Various experiments have shown that decreasing the feeding level after breeding has increased embryonic survival. Gossett and Sorenson (1959) recorded an average of 7.7 embryos from 52 gilts slaughtered 40 days post breeding. The gilts on the low energy ration group had an average of 1.3 more embryos than those on the high level. Haines <u>et al</u>. (1959) reported that embryonic mortality from ovulation to farrowing was increased 11.7 percent by full-feeding during gestation as opposed to limited feeding. At total of 69 gilts were used to provide average ovulation rate at the second estrus. Twenty-nine gilts were allowed to farrow and the difference between average number ovulated and number farrowed was described as embryonic mortality. A portion of their embryonic mortality may be attributed to the failure of ova fertilization since they assumed 100 percent fertilization. Self et al. (1955) noted that embryonic death was much higher among full-fed gilts (67 percent) than among limited-fed gilts (43 percent) as measured by the number of normal embryos at 25 days.

Condition change during gestation was studied by Dean et al. (1958) using changes in backfat as their measure of condition. Using 46 gilts, they found that condition change from breeding to farrowing was negatively correlated (-.31) with the number of pigs farrowed. This agrees with results by Omtvedt et al. (1965) whereby a negative correlation was obtained between gestation weight gain and litter size.

Dean and Tribble (1960a, 1960b, 1961) observed the results of limited versus full feeding during gestation in a total of eight trails, four with gilts and four with sows. Normal-fed females received NRC requirements; whereas, limited-fed received only 60-70 percent as much energy in their ration. Condition was measured by means of backfat probes at breeding, farrowing and weaning. They found that sows and gilts which lost condition during gestation farrowed and weaned larger litters in all trials. A definite relationship existed between changes in backfat thickness during gestation and the number of pigs farrowed in that each millimeter increase in backfat was associated with a decrease of 0.15 pigs farrowed per litter. In the gilt study, the correlation between the change in backfat thickness from breeding to farrowing and litter size at birth was -.31. However, this relationship was not evident in their sow data. More pigs were farrowed alive by limited-fed sows and gilts, but their average birth weight was lower as would be expected. Generally, sows and gilts that lost in condition during gestation gained more during lactation than those fed according to NRC requirements.

Donald and Fleming (1938) attempted to increase pig birth weight by increased feeding of the sow during gestation. Neither pig birth weight nor total birth weight of the litter was affected by a weight increase in the pregnant sow. Zeller, Johnson and Craft (1937) reported a tendency for the number of pigs farrowed to increase with increases in sow weight gain during gestation. The faster gaining sows that gained between 1.01 and 2.25 lbs. per day farrowed 0.67 more pigs. This group was composed of 360 sows or 55 percent of his total population. They also weaned 0.72 more pigs than did the slower gaining group.

Farrowing Weight and Condition

Sow condition at farrowing has been shown to influence litter size and pig weight. Vestal (1938) compared sows in medium and fat condition eliminating sows in a poor condition from the study, since it was felt that they could not stand the stress of milk production. The 70 litters from the medium condition sows contained the heavier and stronger pigs at birth. There were also fewer stillbirths and they weaned 14 percent more of their pigs than did the fat sows.

Smith (1960) produced sows in either a high or low condition at farrowing by limiting their feed intake during gestation. Sows maintained in the high condition gained from 110-130 lbs. during gestation, while low condition sows gained 60-80 lbs. in this same period. Milk yield measurements were conducted every seven days for a period of 12 hours and changes in litter weight before and after suckling was the criterion of measurement. Those in the low condition at farrowing lost less weight and gave slightly less milk during lactation. They also gave birth to 0.8 more pigs, however, they weaned fewer of those which they farrowed alive.

Lactation Weight and Condition Change

Since sows producing the most milk also tended to lose the most weight, it would seem desirable to study weight changes during lactation. The extra volume of milk produced would also increase weaning weight. Allen, Baker and Lasley (1955) evaluated milk production by litter weight changes over eight hour periods and found that on a within-breed basis, both milk production and litter weaning weight were correlated with sow weight loss during lactation. However, the magnitudes of their correlations were not reported. In a later study, Allen, Lasley and Tribble (1959) obtained a correlation of -.58 between milk yield and sow weight loss during lactation. This would indicate that sows giving the most milk were also losing the most weight. Allen and Lasley (1960) on an overall breed basis found a correlation of 0.45 between size of litter suckled and milk production. This would support the work of Smith and Donald (1938) as they reported that up to a certain point as litter size increases, so will milk production. Allen and Lasley (1960) also reported a correlation of 0.58 between litter weaning weight and milk production. Sows producing the most milk were also weaning the heaviest litters. They found that gilts from breeds that were fatter at 200 lbs. gave less milk in their first lactation.

Omtvedt, Whatley and Willham (1966) reported sow lactation gain was associated with number of pigs weaned per litter (-.55) and litter weaning weight (-.58). Their correlation of 0.19 between pig weaning weight and sow lactation gain was attributed to heavier pigs being in the smaller litters and thus resulting in less strain on the sow.

CHAPTER III

MATERIALS AND METHODS

Data utilized in this experiment were collected from sows and their litters born from the fall of 1965 through the fall of 1968 in the swine breeding project herds at Stillwater and the Fort Reno Livestock Research Station.

The study was divided into two parts: The first part included four lines of breeding and 141 litters to establish the relationship between sow condition and productivity, and the second part utilized 341 litters from two lines of breeding to study the effectiveness of individual feeding in reducing variability in condition. The distribution of litters by line, age of dam and season are given in Tables II and III. Only litters from gilts and second litter sows were considered for the study.

Condition Study

In the fall of 1965, before individual sow feeding stalls were used, individual sow condition at farrowing could not be regulated. Gestating sows were limited fed in groups of 15, but it was apparent that the more aggressive sows tended to have a greater feed intake than the more timid ones. This was the only season that sow condition was not regulated by feeding in at least one line.

TABLE II

DISTRIBUTION OF LITTERS BY LINE OF BREEDING, SEASON AND AGE OF DAM FOR THE CONDITION STUDY

Season	OK 14 (Hamp)		OK 24 (Crossbred)		OK 8 (Duroc)	OK 9 (Belts)
	Gilts	Sows	Gilts	Sows	Sows	Sows
1965 Fall	18	7	10	16	20	26
1966 Spring	—	14	21	9	—	—
TOTAL	18	21	31	25	20	26

TABLE III

DISTRIBUTION OF LITTERS BY LINE OF BREEDING, AGE OF DAM AND SEASON USED TO STUDY CHANGES IN CONDITION VARIABILITY

Season	OK 14 (Hamp)		OK 24 (Crossbred)	
	Gilts	Sows	Gilts	Sows
1965 Fall	18	7	10	16
1966 Spring	12	14	21	9
1966 Fall	25	5	17	10
1967 Spring	21	13	19	11
1967 Fall	17	14	12	11
1968 Spring	19	9	21	10
TOTAL	112	62	100	67

There were four lines of breeding represented in the condition study. These included OK 14, a purebred Hampshire herd; OK 24, a random mating control herd; OK 8, a purebred Duroc herd; and OK 9, a purebred Beltsville No. 1 herd. Line 14 was maintained at Stillwater and consisted of approximately 40 litters farrowed per season. Line OK 14 was selected on the basis of overall merit considering growth rate, backfat thickness, and meatiness. Line OK 24 was maintained at Fort Reno and consisted of 30 boars and 30 sows with the primary purpose of measuring the progress obtained in the crossbreeding program. In this line, two average boars and two average gilts were selected from each litter at 21 and 42 days, respectively. These pigs were then grown out to 200 lbs. and backfat probes taken. Post-weaning daily gain and average backfat thickness were calculated; and the boar and gilt from each litter that was closest to the average, with respect to these traits, were retained to propagate the line in an effort to have a zero selection differential for growth rate and backfat thickness in the line. Each boar was mated to only one gilt, and the matings were random except that individuals with a common ancestor in the first two generations were not permitted to mate. Gilts farrowed at approximately one year of age, and sows held over for a second litter were repeat mated to the same boar. Lines OK 8 and OK 9 were purebred Duroc and Beltsville No. 1, respectively, used in the reciprocal selection study at Fort Reno. Since these two lines did not have purebred pigs farrowed every season, they could only be considered for one season.

All pigs were weaned at 42 days of age. Traits examined in the study were: number of pigs farrowed alive, average pig birth weight, litter birth weight, number of pigs weaned, survival rate to weaning, average pig weaning weight and litter weaning weight. Characteristics of sows evaluated were weight and condition score at breeding, 109 days postbreeding and at weaning. Table IV describes the sow condition scoring system.

TABLE IV

DESCRIPTION OF SOW CONDITION SCORING SYSTEM

	Score	Description
	9	
High	8	High condition. Considered to be overfat.
	7	
	6	
Average	5	Moderate condition. Considered to be ideal condition.
	4	
	3	
Low	2	Poor condition. Considered to be underfinished.
	1	

Sow weight at 109 days minus the litter birth weight was used as the corrected weight for the sow at farrowing. Sow weight changes for gestation and lactation were also included in the analysis. Sow weight change during lactation was computed using the corrected farrowing weight and the sow's weight at weaning. Sows were full-fed during lactation.

Condition Variability

Only lines OK 14 and OK 24 that were represented each season were used to study the effectiveness of individual feeding to reduce variability in condition scores. Replacement gilts were selected at 200 lbs. in both the Stillwater and Fort Reno herds. They were started on a milo-wheat-soybean meal sow ration containing 17 percent crude protein, 0.8 percent calcium and 0.7 percent phosphorous. Sows and gilts were bred for spring farrowings in February and March and fall farrowing in August and September.

Starting in the spring of 1966, individual sow feeding stalls were introduced into both herds. Only the gilts in the OK 14 line had access to the stalls in the spring of 1966; however, all animals with the exception of OK 14 sows were fed in the stalls by the fall of 1966. Both sows and gilts were fed in groups of 15. Beginning in the fall of 1966, an attempt was made to individually control the feed level so all animals reached a medium condition (Score 4, 5, or 6) at farrowing. Gilts were hand fed 3.5-4 lbs. of feed per day until approximately two weeks before breeding, at which time they were flushed by increasing their feed intake to 5 lbs. of feed per day. Immediately after breeding, their feed intake was reduced to 3.5-4 lbs. per day until a month before farrowing. The exact amount of feed intake was regulated by the herdsmen on an individual animal's condition basis. Prior to using feeding stalls, the same amounts of feed were fed; however, there was no assurance that any animal received only their proper share. Prior to farrowing, the feed intake was again raised to 5.5-6 lbs. per day; again this amount was regulated by the condition of the gilt.

Sows were managed similar to the gilts with the only difference being that sows received 1-1.5 lbs. more feed per day in each feeding period. During lactation, both sows and gilts were on full feed.

Statistical Analysis

The data were analyzed using the IBM 360 located at Oklahoma State University Computing Center. Phenotypic correlation coefficients were first computed within line, age of dam and season. Pooled correlations were then obtained by adding the corrected sums of squares and cross-products for the sows and gilts separately for each line and season.

Partial correlations were obtained using the formula below as described by Snedecor and Cochran (1967):

$$r_{12.3} = \frac{r_{12} - r_{13}r_{23}}{\sqrt{(1-r_{13}^2)(1-r_{23}^2)}}$$

Beginning in the spring of 1966 for Line 14 gilts and in the fall of 1966 for all other lines, except OK 14 sows, the researchers fed in individual feeding stalls and thus attempted to control the condition of the animal at farrowing. Two methods were used to determine if limited feeding reduced the variance in sow farrowing score. Coefficients of variation were calculated within each season, line of breeding and age of dam to see if the variance was being reduced from season to season. Variances, within line of breeding and age of dam, were also computed and compared to see if there was a significant reduction as a result of individually feeding in stalls.

CHAPTER IV

RESULTS AND DISCUSSION

Means and standard deviations for sows and gilts are summarized in Table V. Sows farrowed and weaned more and heavier pigs than did gilts. Carmichael and Rice (1920) and Ellinger (1921) showed number of pigs farrowed to be greater for sows than for gilts. Omtvedt _et al_. (1965) also found significant differences for age of dam when number farrowed was considered. Larger pigs at birth might also be expected to weigh heavier at weaning. Blunn, Warwick and Wiley (1959) found significant positive relationships between birth weight and: 56 day weight (0.53) and gain from birth to 56 day (0.44).

Gilts weaned a greater percentage of the pigs they farrowed than did sows. Omtvedt _et al_. (1966) also found this relationship existing. This greater survival percentage might be associated with the fewer number of pigs farrowed by gilts as opposed to sows. Weaver and Bogart (1943) found that survivability was increased for smaller litters. Winters, Cummings and Stewart (1947) also found that an increase in size of litter had a depressing effect on survival percentage. However, in their study, average pig birth weight was a more important factor in survivability.

Sows weighed more than gilts at breeding, farrowing and weaning. They also gained slightly more during gestation. Sows and gilts lost approximately the same amount of weight during lactation. Even though

TABLE V

MEANS AND STANDARD DEVIATIONS FOR PREWEANING TRAITS, SOW WEIGHTS AND SOW CONDITION SCORES POOLED WITHIN YEAR AND SEASON FOR GILTS AND SOWS

Traits	Gilts		Sows	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Number pigs farrowed alive	9.9	2.15	10.9	2.67
Survival percentage	85.65	15.79	82.83	16.77
Average pig birth weight, lb.	2.88	0.37	3.11	0.43
Litter birth weight, lb.	28.26	6.01	33.47	7.62
Number pigs raised to 42 days	8.2	2.16	8.6	2.60
Average pig weaning weight, lb.	24.28	3.91	29.41	3.82
Litter weaning weight, lb.	197.16	52.40	250.35	71.73
Sow breeding weight, lb.	279.20	23.95	365.35	37.78
Sow 109 day weight, lb.	389.47	35.05	478.52	45.63
Sow gestation gain, lb.	109.97	23.12	113.17	32.92
Sow 109 day weight - litter weight, lb.	361.21	34.29	445.05	44.47
Sow weaning weight, lb.	343.16	40.89	427.10	45.41
Sow lactation gain, lb.	(-)17.72	3.29	(-)17.90	3.44
Score at breeding	6.12	0.88	5.01	1.55
Score at 109 days	5.82	1.06	5.72	1.32
Sow gestation score change	(-)0.30	1.04	0.69	1.14
Score at weaning	4.73	1.44	4.81	1.51
Sow lactation score change	(-)1.09	1.32	(-)0.90	1.39

sows and gilts gained about the same amount of weight during gestation, the corresponding condition score change indicates that the additional weight in gilts was used for growth while in sows it was used for condition. During lactation, gilts tended to lose more in condition than did sows.

Relationship of Sow Weights and Condition Scores to the Productivity Traits

Sow Breeding Weight

Table VI gives the phenotypic correlations for breeding weight and score. It can be generally stated that breeding weight in sows and gilts tended to be positively associated with more pigs farrowed alive, greater pig birth weight and, as a consequence of these two, a greater litter birth weight. Omtvedt et al. (1965) reported that breeding weight of the dam was positively correlated to litter size (0.19) and litter birth weight (0.24) but not significantly correlated (0.06) with average pig weight at birth.

Sow Breeding Score

Both sows and gilts tended to have a negative correlation between score at breeding and number farrowed alive. This would indicate that sows and gilts in a better condition at breeding farrowed fewer pigs. This would seem to be different from all the work done on flushing and the related increase in number farrowed by Christian and Nofziger (1952); Haines et al. (1955) and Zimmerman et al. (1957). However, the condition score at breeding was for that particular period only and it does not refer to any change in condition in the last two weeks to a month before breeding.

TABLE VI

PHENOTYPIC CORRELATIONS FOR BREEDING SCORES AND BREEDING WEIGHTS POOLED WITHIN BREED, YEAR AND SEASON FOR GILTS AND SOWS

Traits Correlated	Gilts (n = 49)	Sows (n = 92)	Overall (n = 141)
Breeding score and:			
Number farrowed alive	-.17	-.07	-.09
Average pig birth weight	-.04	0.13	0.09
Litter birth weight	-.18	0.01	-.04
Breeding score[a] and:			
Number farrowed alive	-.19	-.25*	-.21*
Average pig birth weight	-.05	-.01	-.01
Litter birth weight	-.21	-.24*	-.23**
Breeding weight and:			
Number farrowed alive	0.16	0.05	0.07
Average pig birth weight	0.13	0.14	0.13
Litter birth weight	0.24	0.13	0.16

[a]Partial correlation with breeding weight held constant.

*P < .05.

**P < .01.

Gilts, which were in a better condition at breeding, as indicated by their breeding score, tended to have smaller pigs and lighter litter birth weights while sows showed the opposite results. Since breeding score could be influenced by weight at breeding, partial correlations were calculated holding breeding weight constant. These correlations indicated that breeding score was significantly negatively correlated with number farrowed alive (-.25) for sows and (-.21) overall. This indicates that number farrowed alive is significantly associated with condition at breeding and not necessarily with an increase in breeding weight. Also litter birth weight was negatively correlated with breeding score when breeding weight was held constant. This decrease in litter birth weight is primarily a function of litter size (r = 0.83) as described by Omtvedt et al. (1965).

Sow Gestation Weight Change

The phenotypic correlations between sow gestation weight or condition change with the farrowing traits are presented in Table VII. Gestation weight change was significantly correlated with pig birth weight in sows (0.26). Gilts tended to farrow fewer pigs and have heavier litter birth weights if they gained weight during gestation. Various authors have stated that greater weight gains during gestation are associated with increased embryonic mortality, thus fewer pigs are farrowed alive (Haines et al. 1959; Gossett and Sorenson, 1959; Self et al. 1955; Robertson et al. 1951a; and Stewart, 1945). Omtvedt et al. (1965) reported gestation gains were negatively correlated (-.14) with litter size and positively correlated (0.16) with average pig weight at birth when the data were pooled over age of dam. In the present study sows with greater weight gains were associated with more pigs farrowed alive and increased average pig birth weight. Sows which had greater increases in weight during gestation also had significantly heavier ($P < .05$) litter birth weights. This increase in litter birth

TABLE VII

PHENOTYPIC CORRELATIONS FOR GESTATION SCORE CHANGE AND WEIGHT CHANGE POOLED WITHIN BREED, YEAR AND SEASON FOR GILTS AND SOWS

Traits Correlated	Gilts (n = 49)	Sows (n = 92)	Overall (n = 141)
Sow gestation score change and:			
Number farrowed alive	-.25	-.04	-.10
Average pig birth weight	-.15	-.01	-.05
Litter birth weight	-.29*	-.09	-.16*
Sow gestation score change[a] and:			
Number farrowed alive	-.30*	-.15	-.24**
Average pig birth weight	-.40**	-.07	-.15
Litter birth weight	-.48**	-.27**	-.34**
Sow gestation weight change and:			
Number farrowed alive	-.01	0.16	0.13
Average pig birth weight	0.27*	0.11	0.14
Litter birth weight	0.13	0.26*	0.22**

[a]Partial correlations with sow weight change held constant.

*P < .05.

**P < .01.

weight can be attributed to either more or larger pigs in the litter. Carmichael and Rice (1920) observed that in litters of less than average numbers, average pig weight increased and litter weight increased with number farrowed. Winters *et al*. (1947) indicated there was a significant negative correlation (-.32) between average pig birth weight and size of litter. Lush *et al*. (1934) noted a curvilinear relationship between litter size and birth weight. The positive relationship between weight gain and number farrowed alive was not significant in sows. Zeller *et al*. (1934) reported a tendency for number of pigs farrowed to increase with sow weight gain during gestation. Donald and Fleming (1938) found that neither pig birth weight nor litter birth weight increased with sow weight gain during gestation.

Sow Gestation Score Change

Sows and gilts which gained in condition during gestation tended to farrow fewer and smaller live pigs. In gilts a significant negative correlation was found between litter birth weight and gestation score change. This would indicate that gilts which gained in condition during gestation farrowed lighter litters. The same trend was evident for sows, but no significance was obtained. When the data were pooled over age of dam, a significant ($P < .05$) relationship was found between gestation score change and litter birth weight. These results support the work of Dean *et al*. (1958) and Dean and Tribble (1960a, 1960b, 1961). Dean *et al*. (1958) found a negative correlation (-.31) between gestation condition change and number of pigs farrowed. Dean and Tribble (1960a, 1960b, 1961) found that sows and gilts which lost condition during gestation farrowed larger litters.

When gestation weight change was held constant, significant negative correlations were found between gestation score change and number farrowed alive (-.30), average pig birth weight (-.40) and litter birth weight (-.48) in gilts; however, only litter birth weight (-.27) was significant in sows. These relationships indicated that as condition increased during gestation, fewer pigs were farrowed alive. Also, if condition increased during gestation, average pig weight and litter birth weight were decreased. Full feeding has been shown by many workers to be associated with increased embryonic mortality in gilts (Haines _et al_. 1959; Self _et al_. 1955; and Gossett and Sorenson, 1959). Usually this full feeding has resulted in greater weight gains; and, since gestation weight gains were correlated (0.53, $P < .01$) with gestation score change in this study, it would also result in an increase in gestation score change. Gilt litters appeared to be more affected than sows by changes in condition during gestation if weight change is held constant. Although no significant correlations were obtained between sow condition change and number farrowed alive or average pig weight, sows tended to farrow fewer and smaller pigs if they had gained in condition during gestation. When the correlations were pooled over age of dam holding weight constant, gestation score change was negative correlated ($P < .01$) with number farrowed alive (-.24) and litter birth weight (-.34). From these partial correlations, it would seem that these three traits were associated with condition changes during gestation and this association did not depend upon weight change.

Sow Farrowing Weight

Table VIII lists the phenotypic correlations between sow weight and condition at farrowing and the farrowing results. There was a positive relationship between farrowing weight and number farrowed alive, average pig birth weight and litter birth weight for both sows and gilts. Significant results were obtained only between sow farrowing weight and average pig birth weight (0.20) and litter birth weight (0.23). Sows that weighed more at farrowing, farrowed larger pigs and their litters weighed heavier. These same results were found when the data were pooled over age of dam.

Sow Farrowing Condition

Over all weights, gilts which were lower in condition at farrowing farrowed more pigs ($r = -.36$). These gilts also had heavier litter birth weights ($r = -.34$). In sows, the same trends were available, however, no significant correlations were obtained. Sows that were in better condition at farrowing farrowed heavier pigs at birth. This could be explained by their also having fewer pigs farrowed alive. When the data were pooled over age of dam, only number farrowed alive (-.18) was significantly correlated ($P < .05$) with sow condition at farrowing. This would seem to point out that for increased productivity at farrowing, a sow would need to be in low or medium condition. These conclusions are supported by the work of Smith (1960) who found that sows in a low condition at farrowing gave birth to 0.8 more pigs than those in a high condition. Vestal (1938) found that sows in a medium condition farrowed stronger and heavier pigs at birth than sows in a fat condition.

TABLE VIII

PHENOTYPIC CORRELATIONS FOR FARROWING SCORES AND FARROWING WEIGHTS POOLED WITHIN BREED, YEAR AND SEASON FOR GILTS AND SOWS

Traits Correlated	Gilts (n = 49)	Sows (n = 92)	Overall (n = 141)
Sow 109 day score and:			
Number farrowed alive	-.36*	-.11	-.18*
Average pig birth weight	0.0	0.14	0.07
Litter birth weight	-.34*	-.06	-.13
Sow 109 day score[a] and:			
Number farrowed alive	-.41**	-.18	-.25**
Average pig birth weight	-.08	0.06	-.02
Litter birth weight	-.46**	-.19	-.26**
Sow 109 day weight and:			
Number farrowed alive	0.11	0.10	0.15
Average pig birth weight	0.26	0.20*	0.21*
Litter birth weight	0.26	0.23*	0.24**

[a]Partial correlation with 109 day weight held constant.

*P < .05.

**P < .01.

When farrowing weight was held constant and partial correlations were computed between sow farrowing score and the three productivity traits, increases in the correlations were noted. In gilts highly significant correlations (P < .01) were found between score and number farrowed alive (-.41) and litter birth weight (-.46). These correlations point out the fact that within a weight classification, condition is certainly important, especially in gilts. Condition is also important in sows, but to a lesser degree. When the data were pooled over age of dam, the same two traits were again highly significant.

These results would seem to also indicate that condition is important at farrowing, and high condition is not wanted since it will result in fewer pigs farrowed alive and lighter litter birth weights.

Sow Weaning Weight

Larger sows and gilts at weaning weaned significantly ($P < .01$) fewer pigs (-.38 and -.44, respectively) as expressed in Table IX. Heavier pigs were weaned by larger sows (0.30) and larger gilts (0.38). These results might be expected as the heavier sows and gilts at weaning did not have as much lactation stress as lighter sows and gilts that had more pigs weaned and smaller average pig weaning weight. Individual pig weight increased as number of pigs in the litter decreased. These results are supported by Omtvedt et al. (1966) who attributed the positive correlation (0.19) between pig weaning weight and sow lactation gain to the fact that heavier pigs occurred in smaller litters resulting in less strain on the sow. Also, the correlation between average pig weight at 42 days and number weaned per litter was found to be -.61. Gilts and sows who were lighter at weaning weaned significantly heavier litters (-.27, $P < .05$ and -.29, $P < .01$) respectively. This was to be expected as litter weight was a function of litter size and it was also negatively correlated. Omtvedt et al. (1966) found that litter weaning weight was largely determined by the number of pigs in the litter. Gilts that were lighter at weaning weaned a greater percent of their offspring that were farrowed alive as evidenced by the correlation of -.40 ($P < .01$) between gilt weaning weight and survival percentage. The same trend was evident in sows; and, when the data were pooled, a highly significant correlation (-.22) was found.

TABLE IX

PHENOTYPIC CORRELATIONS FOR SOW WEANING SCORE AND WEANING WEIGHT POOLED WITHIN BREED, YEAR AND SEASON FOR GILTS AND SOWS

Traits Correlated	Gilts (n = 49)	Sows (n = 92)	Overall (n = 141)
Sow weaning score and:			
Number raised to 42 days	-.64**	-.39**	-.47**
Average pig weaning weight	0.31*	0.19	0.23**
Litter weaning weight	-.52**	-.36**	-.41**
Survival percentage	-.50**	-.31**	-.25**
Sow weaning score[a] and:			
Number raised to 42 days	-.65**	-.20	-.35**
Average pig weaning weight	0.28*	-.02	0.09
Litter weaning weight	-.51**	-.24*	-.32**
Survival percentage	-.49**	-.30**	-.17*
Sow weaning weight and:			
Number raised to 42 days	-.44**	-.38**	-.39**
Average pig weaning weight	0.38**	0.30**	0.32**
Litter weaning weight	-.27*	-.29**	-.28**
Survival percentage	-.40**	-.13	-.22**

[a]Partial correlations with sow weaning weight held constant.

*P < .05.

**P < .01.

Sow Weaning Condition

From Table IX it is evident that both gilts and sows should be in a low condition at weaning if large litters are expected. Both gilts and sows weaned more pigs per litter as evidenced by the highly significant negative correlations of -.64 and -.39, respectively. Average pig weaning weight was positively correlated with sow weaning condition (0.31, P < .05) for gilts compared to 0.19 in the case of sows. As it has already been stated that litter weaning weight was primarily a function of litter size, the highly significant negative correlations of -.52 and -.36 for gilts and sows were expected. Condition at weaning was also important when survival percentage was considered. Gilts (-.50) and sows (-.31) weaned significantly more of the pigs which had been farrowed alive if they were lower in condition at weaning. When weight was held constant, the gilt correlations remained almost the same. However, in sows a decrease of the correlations was noted. This would indicate that within a given weight in sows, condition was not as important as it was across all weights.

Sow Lactation Weight Change

Results presented in Table X show that a decrease in number of pigs raised to 42 days was associated with a gain in weight during lactation for both gilts (-.47) and sows (-.52). Associated with this decrease in number of pigs weaned was an increase in individual pig weight. This was to be expected as sows and gilts which were gaining in weight during lactation would wean heavier pigs (0.15 and 0.22, respectively), as they had fewer pigs to raise. Sows and gilts that were gaining in weight during lactation had lighter litter weaning weights (-.46 and -.41) and they weaned fewer of their pigs which were born alive, (-.20 and -.51, respectively). Omtvedt et al. (1966) reported that sow lactation gain was associated with litter weaning weight (-.58), with number of pigs weaned (-.55), with pig weaning weight (0.19) and with survival percentage (-.22). The above estimates are based on data pooled over age of dam and agree closely with the pooled overall results in Table X. Allen et al. (1959) found that sows producing more milk during lactation lost more weight (-.58) and a positive correlation (0.38) indicated that as litter size increased so did milk production. From these two correlations we can see that as the number of pigs being suckled increases, so will milk production; and, as a result of this, the sow will tend to lose weight.

TABLE X

PHENOTYPIC CORRELATIONS FOR SOW LACTATION SCORE AND WEIGHT CHANGE POOLED WITHIN BREED, YEAR AND SEASON FOR GILTS AND SOWS

Traits Correlated	Gilts (n = 49)	Sows (n = 92)	Overall (n = 141)
Sow lactation score change and:			
Number raised to 42 days	-.44**	-.48**	-.46**
Average pig weaning weight	-.05	0.16	0.09
Litter weaning weight	-.35*	-.45**	-.41**
Survival percentage	-.49**	-.30**	-.37**
Sow lactation score change[a] and:			
Number raised to 42 days	-.23	-.30**	-.27**
Average pig weaning weight	-.29**	0.0	-.09
Litter weaning weight	-.05	-.20	-.15
Survival percentage	-.15	-.22*	-.21*
Sow lactation weight change and:			
Number raised to 42 days	-.47**	-.52**	-.50**
Average pig weaning weight	0.15	0.22*	0.20*
Litter weaning weight	-.41**	-.46**	-.44**
Survival percentage	-.51**	-.20	-.32**

[a]Partial correlation with lactation weight change held constant.

*P < .05.

**P < .01.

Sow Lactation Score Change

The correlations shown in Table X indicate that as the sows or gilts increased in condition during lactation, they raised fewer pigs to 42 days of age, weaned lighter litters and raised fewer of the pigs that they farrowed alive. Sows who gained in condition during lactation tended to have a higher average pig weaning weight (0.20). The sow results were highly significant between lactation score change and: number raised to 42 days (-.48), litter weaning weight (-.45), and survival percentage (-.30). Gilt results were highly significant between lactation score change and: number raised to 42 days (-.44), and survival percentage (-.49). Lactation score change and litter weaning weight were significantly correlated (-.35).

When sow lactation weight change was held constant, all the correlations except lactation score change with average pig weaning weight in gilts had decreased in value. In general, this indicates that within a given weight change, changes in lactation score are not as important as they are across all weight changes. The weaning traits were more closely correlated to weight changes and, because of the association between weight change and score change, they were also correlated to score change. Within a given weight change, a gilt which lost a greater amount of condition weaned significantly ($P < .05$) heavier pigs (-.29). This is in contrast to the idea of heavier pigs being in smaller litters as the correlation between number raised to 42 days and lactation score change was still negative (-.23) although not significant. These gilts tended to have more pigs, and they did a better job of raising them. When weight was held constant, sows weaned fewer pigs (-.30) if they gained in condition. They also tended to wean lighter litters and fewer of their pigs survived until weaning (-.22). Dean and Tribble (1961) found that number of pigs weaned was negatively correlated (-.21) to lactation condition change in sows but positively correlated (0.07) in gilts. They also found that number weaned was correlated with average pig weaning weight (-.22) in sows and (-.05) in gilts. This would indicate that larger litters had a smaller average pig.

The scoring of sows on condition is an important factor in predicting productivity. Condition scores appear to be more useful during gestation and at farrowing, as they don't depend upon sow weight as closely in these periods. When the sow is lactating and getting full feed, weight change of the sow is a better indicator of productivity. Care should be taken to keep the sow in a medium condition during gestation and at farrowing to assure increased productivity.

Control of Condition Variability

One of the objectives of this study was to see if individual sow condition could be regulated to a medium score (4, 5, or 6) by individual feeding. It will be recalled that individual sow feeding stalls were first introduced into OK 14 gilts in the spring of 1966, into the OK 24 herd (both gilts and sows) in the fall of 1966 and into OK 14 sows in the spring of 1967. Table XI gives the means and standard deviations for sow farrowing score within line, age of dam and season. In the spring of 1966 gilts from the OK 14 herd averaged 6.1 for their farrowing score. This was their first season to use feeding stalls. In the following seasons their average farrowing score was reduced below 6.0, which put them into the medium condition at farrowing. The

TABLE XI

MEANS AND STANDARD DEVIATIONS OF SOW FARROWING SCORE

	OK 14				OK 24			
	Gilts		Sows		Gilts		Sows	
Season	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
1965 Fall	6.4	1.65	6.0	1.73	7.6	1.71	6.5	1.63
1966 Spring	6.1	1.00	5.6	1.45	6.2	1.84	5.6	1.24
1966 Fall	5.2	0.69	5.0	1.00	6.4	0.80	6.2	0.92
1967 Spring	5.6	0.60	4.8	0.60	5.8	0.92	5.9	0.70
1967 Fall	5.4	0.49	5.0	0.78	5.8	0.87	5.6	0.67
1968 Spring	5.5	0.70	4.9	0.60	5.2	0.60	5.1	0.74

same trend is evident in the OK 24 herd after one season in the individual feeding stalls. OK 14 sows never were above the medium condition score range; however, when the feeding stalls were introduced, their average farrowing score was reduced. Figures 1 and 2 give graphic illustrations of the reduction in average farrowing scores for sows and gilts for the two lines of breeding studied. Table XII gives the variances for the sow farrowing score within season, line of breeding and age of dam. Since it has been already pointed out that there was a reduction in the means within each group, it would be important to check if there was also a reduction in the variance indicating a closer grouping of scores about the mean. There was a reduction in variation corresponding to the season in which the stalls were first added except for OK 14 sows. A part of their reduction occurred the season before the stalls were furnished. This can be partially explained by the fact that there were only five second litter sows available in the OK 14 line. The small number combined with their being fed with older sows could be a factor in reducing their score. Highly significant differences ($P < .01$) were found between the 1965 Fall and 1968 Spring seasons in each line and age of dam classification. These were the only seasons compared, as 1965 Fall was the only season where individual feeding was not practiced in at least one line and 1968 Spring represented the terminal year for the study. This points out that there was a significant reduction in the variance of the score as well as a reduction in the average value as shown in Table XI. More of the sows were being fed to a medium condition at farrowing. Table XIII illustrates the coefficients of variation for the farrowing score. It shows the same trends as have been shown in the previous two tables.

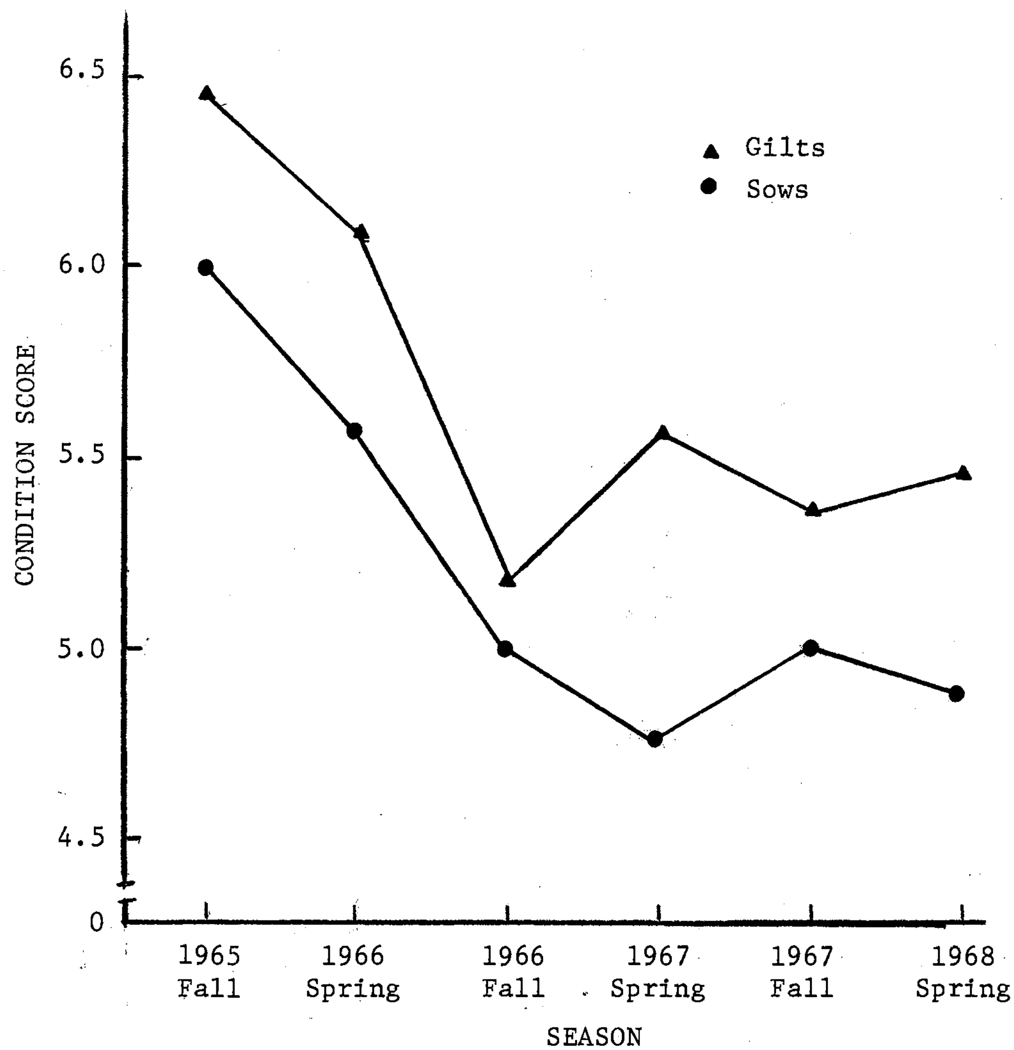

Figure 1. OK 14 Farrowing Score Means Within Age of Dam

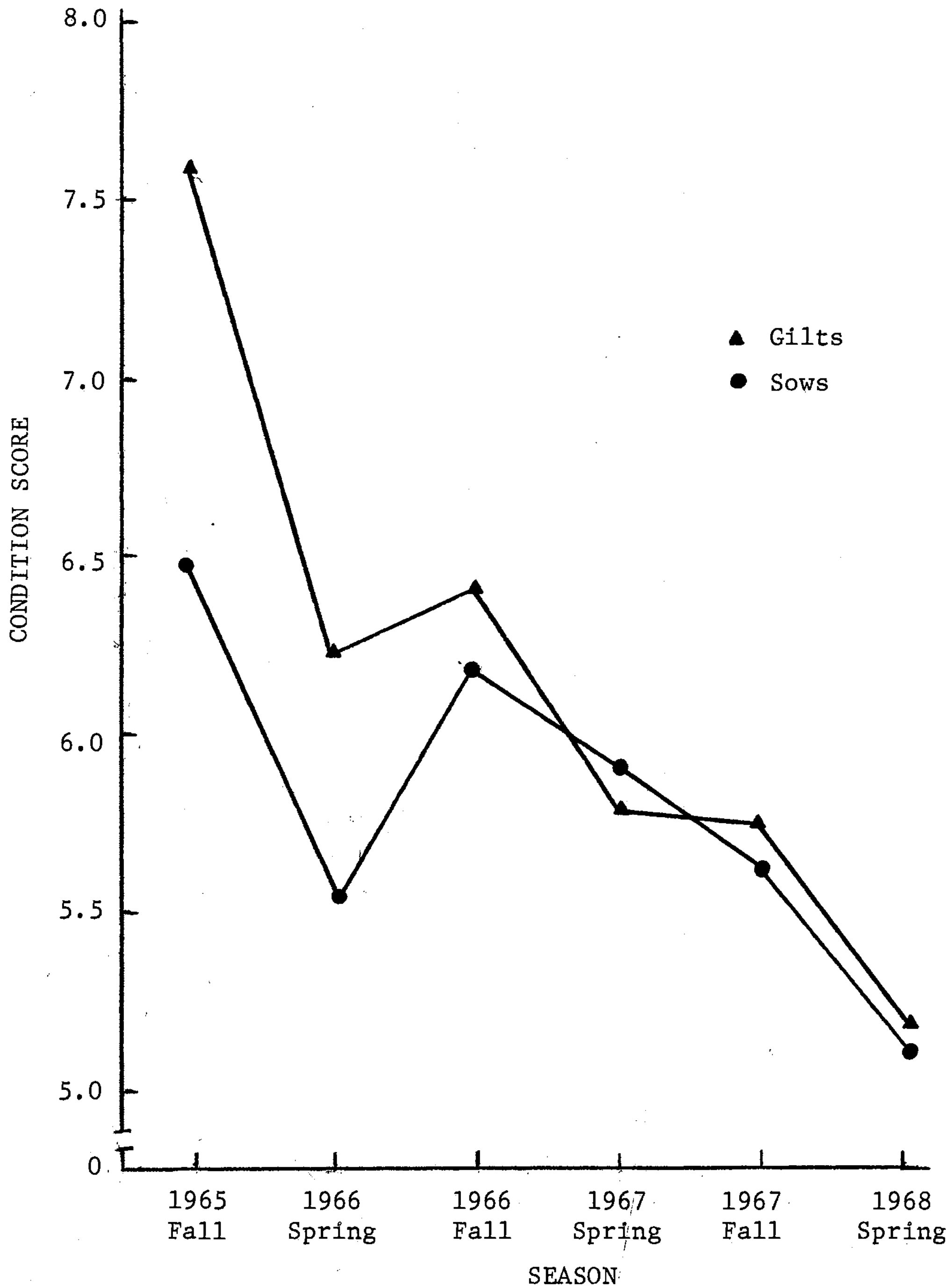

Figure 2. OK 24 Farrowing Score Means Within Age of Dam

As the feeding stalls were introduced, there was a corresponding decrease in the coefficient of variation.

TABLE XII

VARIANCES FOR SOW FARROWING SCORE WITHIN SEASON, AGE OF DAM AND LINE OF BREEDING

Season	OK 14 Gilts	OK 14 Sows	OK 24 Gilts	OK 24 Sows
Fall 1965	2.72	2.99	2.92	2.66
Spring 1966	1.00	2.10	3.39	1.54
Fall 1966	0.48	1.00	0.64	0.85
Spring 1967	0.36	0.36	0.85	0.49
Fall 1967	0.25	0.61	0.76	0.45
Spring 1968	0.49	0.36	0.36	0.55

TABLE XIII

COEFFICIENTS OF VARIATION FOR SOW CONDITION SCORE
109 DAYS POST-BREEDING

Season	OK 14		OK 24	
	Gilts	Sows	Gilts	Sows
1965 Fall	25.6	28.8	22.5	25.1
1966 Spring	16.5	26.0	29.5	22.3
1966 Fall	13.4	20.0	12.5	14.8
1967 Spring	10.8	12.6	15.9	11.8
1967 Fall	9.2	15.6	15.6	11.9
1968 Spring	12.8	12.3	11.6	14.5

CHAPTER V

SUMMARY

Records utilized in this experiment were collected from sows and their litters born from the fall of 1965 through the fall of 1968 in the swine breeding herds at Fort Reno and Stillwater, Oklahoma. The relationship between sow weights and condition scores with the productivity traits was first evaluated using four lines of breeding and 141 litters. The second section involved the study of the effectiveness of individual feeding in reducing variability in condition. This section consisted of 341 litters from two lines of breeding.

The productivity traits which were significantly correlated with sow condition and sow weight included: number of pigs farrowed alive, average pig birth weight, litter birth weight, number of pigs weaned at 42 days, average pig weaning weight, litter weaning weight and survival percentage. All correlations were calculated on a within line, season and age of dam basis and pooled over lines and seasons.

Heavier weights in gilts and sows at breeding and farrowing and a weight gain during gestation tended to be associated with more pigs being born alive, a higher average pig birth weight and an increased litter birth weight. In gilts, however, smaller gestation gains were associated with an increase in the number farrowed alive. Heavier sows at weaning and greater weight gain during lactation were associated with fewer pigs raised to 42 days, lighter litter weaning weight

and lower survival percentage. Heavier sows at weaning and those sows which gained more weight during lactation did have heavier pigs at weaning. This could be because they also had fewer pigs and less strain was placed on the sow.

Lower sow condition score at breeding, farrowing and gestation score change were associated with increased productivity in this study. Since sow condition can be decreased to the point where the sow will be unable to care for the litter, care should be taken to maintain the sow in a medium condition. Negative correlations were observed between breeding score, farrowing score and gestation score change with number farrowed alive and litter birth weight. Average pig birth weight was positively associated with the scores and score changes. Sow weaning score and score change during lactation were negatively correlated with number weaned, litter weaning weight and survival percentage. A higher score at weaning or an increase in condition during lactation was associated with larger average pig weights.

When sow weight was held constant, partial correlations were calculated between condition score and the traits. In general these correlations increased when sow weight was held constant. These same results were shown at farrowing and during gestation. When weight was held constant at weaning and for lactation gain, it revealed that condition was not as important within a weight classification as it was across all weights. Since weight and condition score were highly correlated at these two periods, the weight change or weight at weaning would be all you would need to predict productivity for the sow. As they were on full feed during lactation, those sows which were lighter at weaning or had lost the greatest amount during lactation had raised larger litters.

The control of sow condition at farrowing was achieved with the use of individual feeding stalls. With the use of feeding stalls, feed intake could be regulated by the herdsman; and thus sow condition could be controlled. As the individual stalls were added to each sow group, condition score variability was reduced approximately 50 percent. The average score was reduced from a high medium to a low medium in each group. Thus, by individual feeding in stalls, not only was the variation in score reduced; but also, by regulating the amount of feed given to a sow, the sow farrowing score could be lowered to a more productive level.

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VITA

2

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